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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, Ichiro Okajima, a citizen of Japan residing at 968-12-1-302, Mutsuura-cho, Kanazawa-ku, Yokohama-shi, Kanagawa 236-0032 Japan and Yasushi Yamao, a citizen of Japan residing at 6-92-38, Uraga-cho, Yokosuka-shi, Kanagawa 239-0822 Japan have invented certain new and useful improvements in

COMMUNICATION METHOD AND MOBILE STATION
IN MOBILE COMMUNICATION SYSTEM

of which the following is a specification:-

TITLE OF THE INVENTION

COMMUNICATION METHOD AND MOBILE STATION IN
MOBILE COMMUNICATION SYSTEM

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a
communication method of a mobile communication
system. More particularly, the present invention
10 relates to a communication method when a mobile
station receives a signal from a base station in the
mobile communication system by diversity reception.

In addition, present invention relates to
a mobile station which carries out communications
15 according to the communication method.

2. Description of the Related Art

Fig.1 shows an example of a conventional
mobile communication system.

As shown in Fig.1, this mobile
20 communication system is configured by a hierarchical
structure wherein radio network controllers 60, 80
control a plurality of base stations 40, 41, 42, 43
which are placed in communication service areas and
a switch 100 controls the radio network controllers
25 60, 80.

For example, a mobile station 18 which
resides in a wireless zone of the base station 43
communicates with the base station 43 and
communicates with another mobile station via the
30 radio network controller 80, the switch 100 and a
predetermined network (which is not shown in the
figure).

The mobile station 18 receives a signal
from the base station 43 according to the antenna
35 diversity reception method for example. According
to the antenna diversity reception method, the error
rate of received signals at the mobile station 18

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5 In addition, the mobile station 19 which
resides in a boundary part between the wireless zone
of the base station 40 and the wireless zone of the
base station 41 receives signals from the base
stations 40, 41 according to a site diversity
0 reception method. According to the site diversity
reception method, the mobile station 19 receives
same signals each of which signals are sent by the
base stations 40 and 41 respectively. Then, the
mobile station 19 synthesizes and selects the
5 signals so that the error rate can be decreased.

According to the site diversity reception method, when the mobile station resides in a boundary part of the wireless zones, the effect of the method can be obtained. However, when the mobile station resides in a central part of a wireless zone of a base station, attenuation of signals from another base station becomes large so that the effect of the diversity reception can not be obtained. Thus, it is necessary to install base stations in higher density for realizing effective site diversity reception. That is, it is necessary to increase the number of base stations which should be installed in the communication service area so that a cost of communication equipment increases.

SUMMARY OF THE INVENTION

It is a first object of the present invention to provide a communication method in a mobile communication system for enabling effective site diversity reception regardless of the physical size of the mobile stations and placement of the base stations.

It is a second object of the present invention to provide a mobile station which performs communication according to the communication method.

The above first object of the present invention is achieved by a communication method used when a mobile station receives a signal from a base station in a mobile communication system, comprising the steps of:

deciding one or a plurality of mobile stations which can communicate with the mobile station via a predetermined wireless network and which can receive a signal from the base station; the one or a plurality of mobile stations sending a signal destined for the mobile station received from the base station to the mobile station via the predetermined wireless network; and the mobile station synthesizing a signal received from the base station and the signal destined for the mobile station received from the one or a plurality of mobile stations.

According to the method in the mobile communication system, since signals destined for the mobile station which are received by the one or a plurality of mobile stations from the base station can be aggregated in the mobile station, the mobile station can perform diversity reception of the signal destined for the mobile station from the base station by synthesizing a signal received from the base station and the aggregated signals.

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In terms of providing a concrete method of deciding the one or a plurality of mobile stations which sends signals destined for the mobile station, the above method may further includes the steps of:

5 forming the predetermined wireless network by the mobile station and other mobile stations in the mobile communication system;

 selecting the one or a plurality of mobile stations among the other mobile stations as mobile
10 stations for diversity reception; and

 the one or a plurality of mobile stations selected as used for diversity reception of the mobile station sending the signal destined for the mobile station received from the base station to the
15 mobile station via the predetermined wireless network.

In terms of decreasing error rate of receiving signals received by diversity reception, the above method may further includes the steps of:

20 selecting the one or a plurality of mobile stations among the other mobile stations such that communication condition between the one or a plurality of mobile stations and the base station is better than predetermined condition.

25 According to the above method, signals destined for the mobile station which are received by the one or a plurality of mobile stations from the base station can be aggregated in the mobile station in which communication condition between the
30 base station and the one or a plurality of mobile stations is good.

 The communication condition depends on a state of the wireless channel between the base station and a mobile station. The state of the
35 wireless channel depends on a distance to the base station (distance of the wireless channel), reflection by a building, radio attenuation, radio

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the mobile station recognizing that the

each mobile station which sends the participation response operates for diversity reception of the mobile station.

5 In terms of selecting the one or a plurality of mobile stations such that the mobile station can perform diversity reception with lower error rate, the above method may further includes the steps of:

10 the each mobile station which receives the participation request measuring a state of receiving a signal from the base station;

15 the each mobile station in which the state is better than a predetermined state recognizing that the each mobile station operate for diversity reception of the mobile station and sending the reception response to the mobile station via the predetermined wireless network.

20 In the above method, the predetermined wireless network may be a mobile ad-hoc network.

20 The above second object of the present invention is achieved by a mobile station which receives a signal from a base station in a mobile communication system;

25 a first transceiver unit which transmits and receives a signal between the mobile station and the base station;

a second transceiver unit which transmits and receives a signal between the mobile station and a first mobile station;

30 network forming control means which forms a predetermined wireless network including the mobile station and the first mobile station by communicating with the first mobile station by using the second transceiver unit; and

35 signal synthesizing means which synthesizes a signal received from the base station by the first transceiver unit and a signal destined

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for the mobile station received from the first mobile station by the second transceiver unit via the predetermined wireless network.

According to the mobile station, diversity reception can be performed when receiving a signal destined for itself from the base station, by synthesizing a signal from the base station and a signal destined for the mobile station received from another mobile station via the wireless network.

The above mobile station may further includes:

transfer control means which sends a signal destined for a second mobile station received by the first transceiver unit to the second mobile station via the predetermined wireless network by the second transceiver unit.

When the mobile station receives a signal destined for another mobile station from the base station, the mobile station transfers the signal to another mobile station via the predetermined wireless network. Accordingly, the another mobile station can perform diversity reception by synthesizing a signal received from the base station and the signal which is transferred.

In terms of providing a concrete function for performing diversity reception by using a signal from another mobile station, the above mobile station may further includes:

participation request send control means which sends a participation request to the first mobile station by the second transceiver unit via the predetermined wireless network, the participation request being a request to operate for diversity reception of the mobile station;

first storing means which stores the first mobile station as used for diversity reception of the mobile station when the second transceiver unit

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signal destined for the second mobile station, the second mobile station being stored in the second storing means.

In addition, the above mobile station may further includes:

receive state measuring means which measures a state of receiving a signal from the base station when the second transceiver unit receives the participation request from the second mobile station via the predetermined wireless network;

second determining means which determines whether the state measured by the receive state measuring means is better than a predetermined state;

wherein the second mobile station which sends the participation request is stored in the second storing means and the participation response control means sends the participation response, by the second transceiver unit, to the second mobile station via the predetermined wireless network when the first determining means determines that a signal from the base station can be received and when the second determining means determines that the state is better than the predetermined state.

Further, in the above mobile station, the predetermined wireless network formed by the network forming control means may be a mobile ad-hoc network.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings, in which:

Fig.1 shows an example of diversity reception in a conventional mobile communication system;

Fig.12 is a flowchart showing an example
35 of a process procedure in a mobile station which
operate as the mobile station for diversity
reception;

Fig.13 is a flowchart showing an example of a process procedure in a mobile station which receives a signal from the base station by diversity reception by using mobile stations for diversity reception; and

Fig.14 shows a state in which a mobile station receives a signal from the base station by diversity reception by using mobile stations for diversity reception.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, embodiments of the present invention will be described with reference to figures.

A mobile communication system of an embodiment of the present invention is configured, for example, as shown in Fig.2. This example is a cellular mobile communication system.

The mobile communication system shown in Fig.2 is a cellular mobile communication system, in which a plurality of base stations 40, 41, 42, 43 which are placed in the communication service areas, radio network controllers 60, 80 and the switch 100 are connected hierarchically in the same way as the conventional communication system. Each base station forms a wireless zone (a cell). Each mobile station in a wireless zone of a base station communicates with the base station. For example, each of mobile stations which reside in the wireless zone of the base station 40 communicates with the base station 40 by using a predetermined wireless channel (which will be called a wireless channel for a cellular network). This is indicated in Fig.2 by a solid line with arrows and dotted lines with arrows. In addition, the mobile stations 11, 12, 13 which reside in a predetermined area form a local wireless communication network, for example, a

5 Each of the mobile stations 11, 12, 13 in
the above-mentioned mobile communication system is
configured, for example, as shown in Fig.3.

30 In this mobile communication system, the
mobile station 11, for example, receives by
diversity reception a signal from the base station
40 by using other mobile stations 12 and 13 (which
will be called mobile stations for diversity
35 reception) which reside in the wireless zone of the
base station 40 and which reside in the mobile ad-
hoc network in the following way.

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The transceiver unit 21 for a cellular network of the mobile station 11 performs two-way communication with the base station 40 by using a predetermined wireless channel for a cellular network so that the transceiver unit 21 receives a signal destined for the mobile station 11. The transceiver unit 21 of each of the mobile stations 12 and 13 for diversity reception receives a downlink signal destined for the mobile station 11. Then, the control unit 23 of each of the mobile stations 12 and 13 passes the received signal destined for the mobile station 11 to the transceiver unit 22 for a mobile ad-hoc network. The transceiver unit 22 for a mobile ad-hoc network sends the received signal destined for the mobile station 11 to the mobile station 11 via the mobile ad-hoc network. When the transceiver unit 22 for a mobile ad-hoc network of the mobile station 11 receives the signals destined for the mobile station 11 from the mobile station 12 and 13, the control unit 23 synthesizes the signal received from the base station 40 and the signals received from the mobile stations 12 and 13.

In the following, the operation of the diversity reception of the mobile station 11 by using the mobile stations 12 and 13 for diversity reception will be described in more detail.

The process for determining other mobile stations as the mobile stations for diversity reception concerning the mobile station 11 is as follows, for example.

Process procedures of the mobile stations 11, 12, 13 and the base station 40 are shown in Fig.4. A process procedure of the control unit 23 of the mobile stations 11 is shown in Fig.5. A process procedure of the control unit 23 of the other mobile stations 12 and 13 is shown in Fig.9.

In Fig.5, the mobile station 11 starts cellular communication with the base station 40 in step 1. Fig.6 shows this state. This communication between the mobile station 11 and the base station 40 is performed, for example, on a wireless channel CH3 (a wireless channel for a cellular network) wherein cellular channel information including an ID (for example ID=BS5) of the base station 40 is sent from the base station 40 to the mobile station 11.

30 Accordingly, when the mobile station 11 is
connected to the mobile ad-hoc network ADH-NW, or,
if the mobile station 11 is already connected to the
mobile ad-hoc network ADH-NW (YES in step 2), the
mobile station 11 sends a participation request to
35 the mobile ad-hoc network ADH-NW in step 4. This
state is shown in Fig.8. A signal used for the
participation request includes cellular channel

The mobile station 11 starts an internal timer in step 5 after sending the participation request for diversity reception over the mobile ad-hoc network ADH-NW. Then, the mobile station 11 determines repeatedly whether it receives a participation response from other mobile station in the mobile ad-hoc network ADH-NW in step 6 while checking whether the timer times out in step 7.

30 The other mobile stations 12, 13, 15 in
the mobile ad-hoc network operate according to Fig.9.

As shown in Fig.9, each mobile station repeatedly determines whether it receives the participation request from a mobile station in the mobile ad-hoc network ADH-NW in step 11. When the mobile station receives the participation request from the mobile station 11, the mobile station

obtains the cellular channel information included in the participation request in step 12. Then, the mobile station determines whether a base station ID which the mobile station receives from a base station and a base station ID included in the participation request are the same in step 13. In this embodiment, since the mobile stations 12 and 13 reside in the wireless zone of the base station 40, it is determined that these base station IDs are the same by the mobile stations 12 and 13. On the other hand, since the mobile station 15 is in a wireless zone of, for example, a base station 42 (ID=BS3), the mobile station 15 determines that these base station IDs are not the same.

After that, the mobile station 15 which determines that these base station IDs are not the same repeatedly determines whether the mobile station 15 receives the participation request from a mobile station in the mobile ad-hoc network ADH-NW in step 11 (waiting state).

On the other hand, the mobile station 12 or 13 which determines that these mobile station IDs are the same measures a receiving level of the wireless channel CH3 used by the base station 40 in the cellular network in step 14. Then, the mobile station determines whether a signal can be received by the wireless channel CH3 on the basis of the receiving level in step 15. In this determination, for example, it is judged whether the receiving level is equal to or more than a threshold level. When it is determined that a signal can not be received by the wireless channel CH3, the mobile station repeatedly determines whether it receives the participation request from a mobile station in the mobile ad-hoc network ADH-NW in step 11 (waiting state).

When it is judged that a signal can be

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5 Then, the control unit 23 of the mobile station
which sends the participation response stores the
mobile station 11 which sent the participation
request in step 17. Accordingly, each mobile
station which sent the participation response
10 recognizes that it performs as the mobile station
for the diversity reception for the mobile station
11 which sent the participation request.

15 participation request from the mobile station 11,
however the mobile station 15 does not send the
participation response. This state is shown in
Fig.10.

As shown in Fig.5, as mentioned above, the mobile station 11 which sent the participation request to the mobile ad-hoc network ADH-NW repeatedly determines whether the participation response is sent from other mobile station in the mobile ad-hoc network in step 6 while checking whether the inside timer times out in step 7. In this state, when the mobile station 11 receives the participation responses from other mobile stations, for example mobile stations 12 and 13, the control unit 23 in the mobile station 11 stores the mobile stations 12 and 13 which sent the participation responses. Accordingly, the mobile station 11 recognizes that the mobile stations 12 and 13 operate as mobile stations for diversity reception for the mobile station 11.

35 When the other mobile stations 12 and 13
which operate as the mobile stations for diversity
reception for the mobile station 11 are determined.

5 Fig.11 shows process procedures in each of
mobile stations 11, 12, 13 and the base station 40.
Fig.12 shows process procedures in each of the
mobile stations 12 and 13 which operate as the
mobile stations for diversity reception. Fig.13
0 shows a process procedure in the mobile station 11.

15 As shown in Fig.12, each of the mobile
stations 12 and 13 which operate as the mobile
station for diversity reception enter a state in
which the mobile stations 12 and 13 receive data
from the wireless channel CH3 of the base station 40,
20 wherein each of the mobile stations 12 and 13
monitors by the transceiver unit 21 for a cellular
network whether a signal (for example, a packet)
destined for the mobile station 11 is received in
step 21. When the mobile station receives a signal
25 destined for the mobile station 11 by the wireless
channel CH3, the mobile station sends, by the
transceiver unit 22 for a mobile ad-hoc network, a
signal including the received signal destined for
the mobile station 11 to the mobile station 11 over
30 the mobile ad-hoc network ADH-NW in step 22. Each
of the mobile stations 12 and 13 repeatedly performs
these processes (steps 21 and 22).

Generally, a signal (a packet, for

5 Further, the signal also includes error correction
code and error detection code. These error
correction code and error detection code are used
for correcting a bit error in the signal which
occurs while the signal is transmitted over the
10 wireless channel and used for determining whether
the correction is properly performed by a mobile
station which received the signal. The mobile
stations 12 and 13 check whether there is a bit
error in the identifying information of the signal
15 received by the wireless channel of the cellular
network by using the error correction code and error
detection code. When there is a bit error, the
signal is discarded. On the other hand, when there
is no error in the identifying information, the
20 mobile stations 12 and 13 determines whether the
identifying information is for the mobile station 11.
If the identifying information is for the mobile
station 11, the signal including the identifying
information is determined to be destined for the
25 mobile station 11.

As shown in Fig.13, the mobile station 11 which performs diversity reception monitors whether it receives a new signal (for example, a packet) from the wireless channel of the mobile station 40 in step 31, and whether it receives a new signal (for example, a packet) from the mobile ad-hoc network ADH-NW in step 32. When a new signal is received from the wireless channel CH3 of the base station 40, the control unit 23 of the mobile station 11 starts the internal timer in step 33 and stores the received signal in an internal memory in step 34. Then, the mobile station 11 determines

whether it receives, from the mobile ad-hoc network ADH-NW, a signal which includes a signal same as that which is stored in the internal memory in step 35 while checking whether the timer times out in
5 step 37.

Then, when the mobile station 11 receives a signal including a signal which is the same as the stored signal from the mobile stations 12 and 13 via the mobile ad-hoc network ADH-NW, the mobile station
10 11 stores the signal in the internal memory in step 36.

While the above-mentioned processes (steps 35, 36, 37) are performed, if the internal timer times out, the signal which is received from the
15 base station 40 and stored in the internal memory, and, the signal received from other mobile stations 12, 13 via the mobile ad-hoc network ADH-NW are synthesized in step 44. This process is performed by a known method, for example, in which blocks
20 except for a block where an error is detected are selected and combined, and by a maximum ration synthesizing method and the like.

As mentioned above, while the mobile station 11 monitors whether it receives a new signal
25 (for example, a packet) from the wireless channel CH3 of the base station 40 (in step 31) and whether it receives a new signal (for example, a packet) from the mobile ad-hoc network ADH-NW (in step 32), there is a case in which the mobile station 11
30 receives a new signal from the mobile ad-hoc network ADH-NW before it receives a new signal from the wireless channel CH3 of the base station 40 (NO in step 31, YES in step 32). In this case, the internal timer is started in step 38, and the new
35 signal received via the mobile ad-hoc network ADH-NW is stored in the internal memory in step 39.

After that, while checking time-out of the

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internal timer in step 43, the mobile station 11 monitors whether it receives the same signal as the stored signal from the wireless channel CH3 of the base station 40 in step 40 and whether it receives the same signal as the stored signal from the mobile ad-hoc network ADH-NW in step 41. In this process, when the same signal is received via the mobile ad-hoc network ADH-NW (No in step 40, YES in step 41), the signal is stored in the internal memory in step 42.

On the other hand, when the same signal is received via the wireless channel CH3 of the base station 40 (YES in step 40), the signal is stored in the internal memory in step 36. After that, while checking time-out of the internal timer in step 37, the mobile station 11 monitors whether it receives a signal same as the signals stored so far via the mobile ad-hoc network ADH-NW in step 35. Then, when the signal is received via the mobile ad-hoc network, the signal is stored in the internal memory in step 36.

In the above-mentioned processes (in steps 40, 41, 42, 43, or in steps 35, 36, 37), when the internal timer times out, signals destined for the mobile station 11 which are stored in the above-mentioned way are synthesized in step 44.

Fig.14 shows a state in which the mobile station 11 receives a signal from the base station 40 by using the mobile stations 12 and 13 which operate as the mobile stations for diversity reception in the above-mentioned way.

In the above-mentioned mobile communication system, since signals destined for the mobile station 11 which are received by the mobile stations 12 and 13 via the wireless channel CH3 of the base station 40 are aggregated in the mobile station 11 via the mobile ad-hoc network ADH-NW, the

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mobile station 11 can receive a signal destined for
itself by diversity reception. In addition, since
mobile stations, in the mobile ad-hoc network, which
can receive signals via the wireless channel of the
5 base station 40 in good condition are selected
dynamically as the mobile station for diversity
reception, the mobile station which performs
diversity reception can always obtain a receiving
signal of lower error rate.

10 Further, since the mobile station for
diversity reception can be selected among any mobile
stations which can communicate with the base station,
good diversity reception which is unaffected by a
location of the base station becomes possible.

15 As mentioned above, according to the
present invention, since diversity reception is
performed by receiving signals from the base station
by using one or a plurality of other mobile stations
which can communicate with the base station, a
20 mobile station which moves in a communication
service area can always receive a signal destined
for the mobile station itself wherever the mobile
station is located. Therefore, effective diversity
reception is always possible for the mobile station
25 without being influenced by the size of the mobile
station, or the location of the base station.

Further, according to the present
invention, a mobile station which can communicate
with other mobile stations according to the above-
30 mentioned communication method can be provided.

The present invention is not limited to
the specifically disclosed embodiments, and
variations and modifications may be made without
departing from the scope of the invention.

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